Magnetic storms catalog for monitoring data of space radio sources fluxes at RT URAN-4 in the zone of the Odessa magnetic anomaly

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Magnetic observatory «Odessa»

The magnetic observatory «Odessa» was founded by the Novorossiysk Imperial University, in the territory of a botanical garden, at the beginning of the XX century. It was officially commissioned in 1896. In 1936 it was transferred to the village of Stepanovka (near Odessa) by the Odessa State University (fig. 1). World War 2th the station became to belong to the Institute of Geophysics NAS Ukraine.

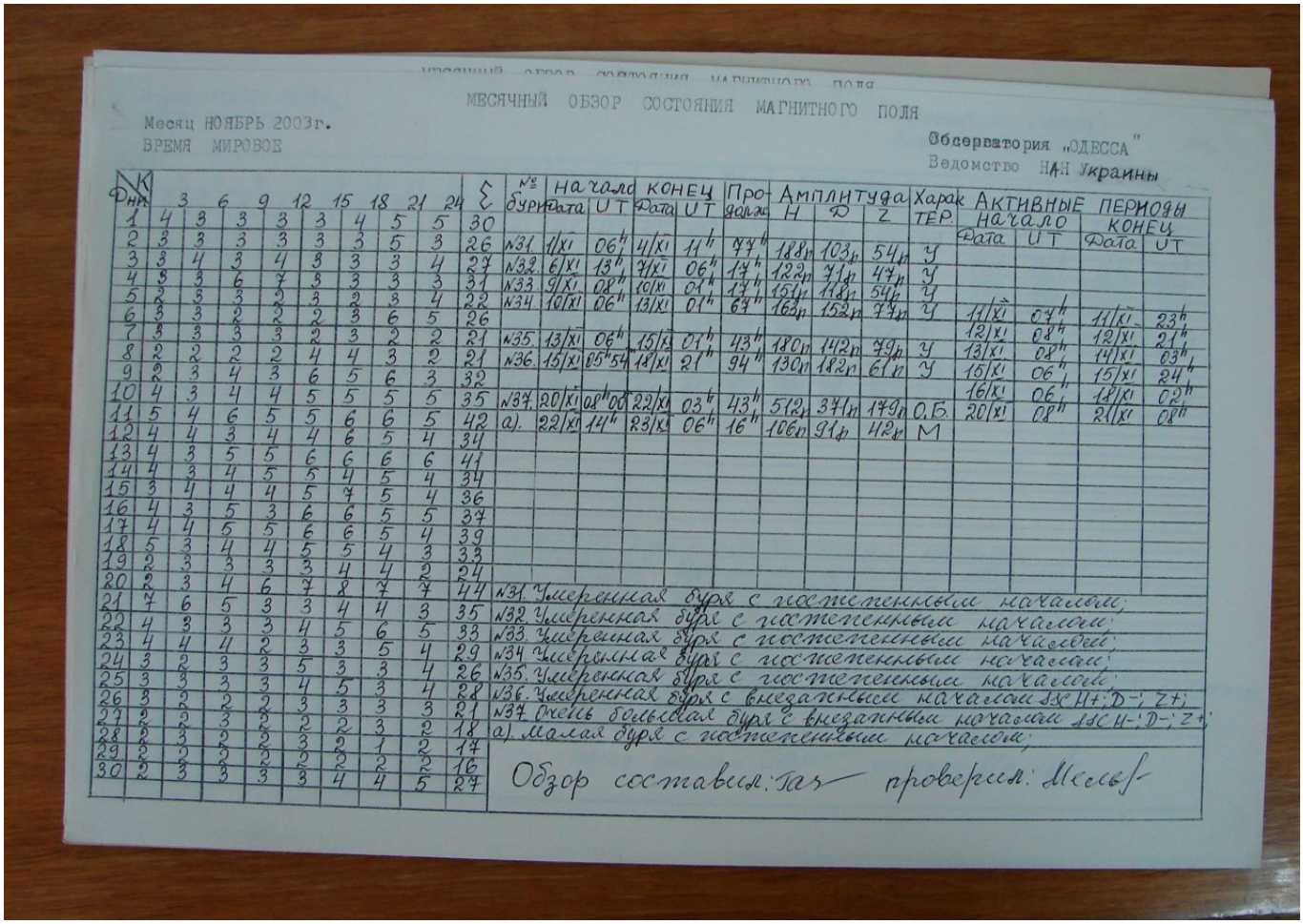
From 1948 to 2010, analog measurements of the Earth's magnetic field were conducted at the «Odessa» magnetic observatory [4]. The magnetometers are located in a deep underground room (fig. 2–4), which makes it one of the best in Ukraine in terms of noise immunity, and the large distance from Odessa (82 km) excludes the contribution of technogenics noise to the measurements of the geomagnetic field induction. At the same time measurements of three elements of a magnetic field are registered: horizontal component (H), vertical component (Z) and declination (D). The recorded data on magnetic storms were presented in tabular form (fig. 5).

Fiure 1. Magnetic observatory "Odessa"

Fig. 2. Underground room of the magnetic observatory "Odessa"

Figure 3. Magnetometer of the magnetic station

Figure 4. Underground room of the magnetic observatory "Odessa”



МЕСЯЧНЫЙ ОБЗОР СОСТОЯНИЯ МАГНИТНОГО ПОЛЯ

Месяц НОЯБРЬ 2003г.
ВРЕМЯ МИРОВОЕ

Обсерватория „ОДЕССА"
Ведомство НАН Украины

Дни	К 3	6	9	12	15	18	21	24	Σ
1	4	3	3	3	3	4	5	5	30
2	3	3	3	3	3	3	5	3	26
3	3	4	3	4	3	3	3	4	27
4	3	3	6	7	3	3	3	3	31
5	3	3	3	2	3	2	3	4	22
6	3	3	2	2	2	3	6	5	26
7	3	3	3	3	2	3	2	2	21
8	2	2	2	2	4	4	3	2	21
9	2	3	4	3	6	5	6	3	32
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21	7	6	5	3	3	4	4	3	35
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23	4	4	4	2	3	3	5	4	29
24	3	2	3	3	5	3	3	4	26
25	3	3	3	3	4	5	3	4	28
26	3	2	2	2	3	3	3	3	21
27	2	2	3	2	2	2	3	2	18
28	2	3	2	2	3	2	1	2	17
29	2	2	2	2	2	2	2	2	16
30	2	3	3	3	3	4	4	5	27

№ бури	Начало Дата	Начало UT	Конец Дата	Конец UT	Продолж.	Амплитуда H	Амплитуда D	Амплитуда Z	Характер	Активные периоды Начало Дата	Активные периоды Начало UT	Активные периоды Конец Дата	Активные периоды Конец UT
№31	1/XI	06h	4/XI	11h	77h	188n	103n	54n	У	11/XI	07h	11/XI	23h
№32	6/XI	13h	7/XI	06h	17h	122n	71n	47n	У	12/XI	08h	12/XI	21h
№33	9/XI	08h	10/XI	01h	17h	151n	118n	54n	У	13/XI	08h	14/XI	03h
№34	10/XI	06h	13/XI	01h	67h	163n	152n	77n	У	15/XI	06h	15/XI	24h
№35	13/XI	06h	15/XI	07h	43h	180n	142n	79n	У	16/XI	06h	18/XI	02h
№36	15/XI	05h54	18/XI	21h	94h	130n	182n	61n	У	20/XI	08h	21/XI	08h
№37	20/XI	08h	22/XI	03h	43h	512n	371n	179n	О.Б				
а).	22/XI	14h	23/XI	06h	16h	106n	91n	42n	М				

№31. Умеренная буря с постепенным началом;
№32. Умеренная буря с постепенным началом;
№33. Умеренная буря с постепенным началом;
№34. Умеренная буря с постепенным началом;
№35. Умеренная буря с постепенным началом;
№36. Умеренная буря с внезапным началом ΔX H+; D-; Z+;
№37. Очень большая буря с внезапным началом ΔX H-; D-; Z+;
а). Малая буря с постепенным началом;

Обзор составил: Гаг — проверил: Мель/

Figure 5. Overview of the state of the magnetic field in November 2003

Electronic catalog of magnetic storms

On the basis of data of magnetic observatory «Odessa» the catalog the magnetic storms is made [5]. This issue of the catalog for 1987-1995 and 2000-2009 years include: date and time of the beginning and end of a storm, the storm duration, amplitude on three elements of a magnetic field are specified: H, Z, D, the characteristic of magnetic storms with the indication of the fissile periods. The catalog was compiled to identify the reasons for the change in the level of the flux of space radio sources, according to observations at the URAN-4 radio telescope at the Odessa Observatory of the Radio Astronomy Institute of the National Academy of Sciences of Ukraine (fig. 6), which have been carried out since 1987. Data on changes in the fluxes of powerful radio sources during periods of extreme states of solar activity are presented in [6]. Paper [6] also presents the results of calculating multiple correlation analysis models, which demonstrates the dependence of changes in the radio sources fluxes on the main indicators characterizing the state of space weather.

Let us consider the most extreme period of space weather of the 23rd solar activity cycle - November 2003. Changes in the radiation flux of the radio source 3C461 during this period are shown in figure 7. The stream changes of a radiation source are shown by small decrease of a stream on November 3-5 and the most noticeable decrease of a stream from November 17 to November 27. During the period from November 2 to November 4 in the Sun there were 4 flashes. The most potent flash (X>17.5) happened on November 4 that entailed recession in radiation source stream level. Recession of a stream of a radiation source was not too larger as the flash happened on the edge of a solar disk and its radiation poorly affected Earth. The next period of a superactivity began since November 17. It was followed by sharp recession of level of a flux of a radiation source which continued till November 27. For three days in this fissile area eight flare of point of M from which two were larger were made. The flare of point 2N during which there were two flares of x-ray point of M3.2 and M3.9 was on November 18 the most interesting event of this period. Potent emission of coronal substance of this flare event caused during very larger and intensive magnetic storm on November 20-21.

Figure 6. The radio telescope URAN-4

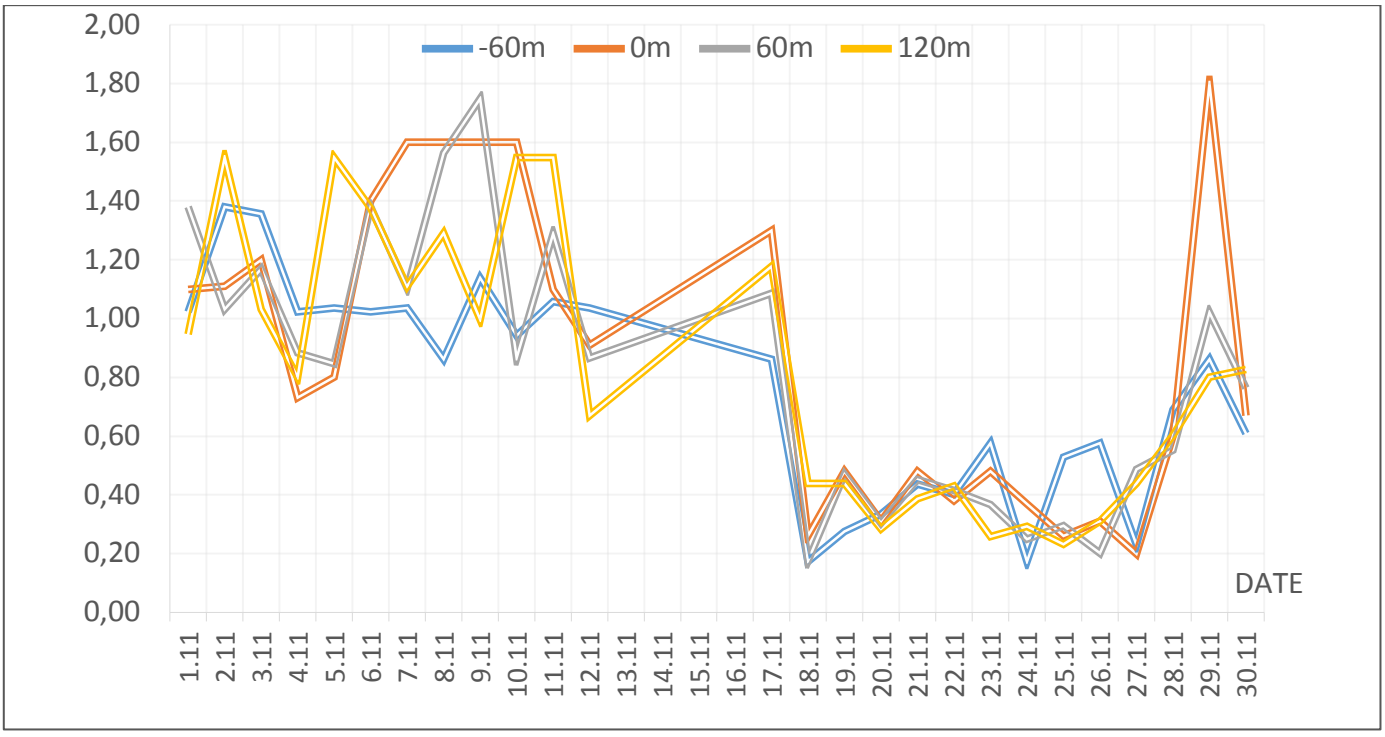

Figure 7. 3C461 radio emission source flux variations on different hour corners (polarization – A, frequency – 25 MHz) in November, 2003

As an example, observational data of the magnetic observatory "Odessa" for the period January-March 2003 are presented at Table 1. The total number of minor, moderate, strong and extreme storms shown in table 2 and figure 8.

Table 1

Digital catalog of magnetic storms and their characteristics

Beginning		End		Duration, h	Amplitude			Storm class	Active periods				Comment
									begin		end		
date	UT	date	UT		H	D	Z		date	UT	date	UT	
03.01.2003	12:00	04.01.2003	0:00	36	95	94	36	minor					Minor storm with the gradual beginning
18.01.2003	6:00	20.01.2003	6:00	48	105	64	39	minor					Minor storm with the gradual beginning
20.01.2003	10:00	23.01.2003	4:00	66	98	68	38	minor					Minor storm with the gradual beginning
29.01.2003	9:00	30.01.2003	20:00	35	116	124	42	moderate					Moderate storm with the gradual beginning
01.02.2003	15:00	05.02.2003	3:00	84	176	145	82	moderate	01.02.2003	18:00	03.02.2003	2:00	Moderate storm with the gradual beginning
									03.02.2003	12:00	04.02.2003	12:00	
08.02.2003	7:00	09.02.2003	3:00	20	75	70	26	minor					Minor storm with the gradual beginning
12.02.2003	8:00	13.02.2003	1:00	17	83	74	26	minor					Minor storm with the gradual beginning
13.02.2003	21:00	15.02.2003	21:00	48	80	105	35	minor	14.02.2003	9:00	15.02.2003	18:00	Minor storm with the gradual beginning
16.02.2003	6:00	17.02.2003	2:00	20	86	62	32	minor					Minor storm with the gradual beginning
26.02.2003	6:00	28.02.2003	1:00	43	106	114	48	moderate					Moderate storm with the gradual beginning
28.02.2003	6:00	01.03.2003	3:00	21	93	85	42	minor					Minor storm with the gradual beginning
03.03.2003	15:00	05.03.2003	3:00	36	92	131	57	moderate					Moderate storm with the gradual beginning
05.03.2003	9:00	07.03.2003	12:00	51	103	96	46	minor					Minor storm with the gradual beginning
20.03.2003	6:00	22.03.2003	2:00	44	119	101	50	moderate					Moderate storm with the gradual beginning
22.03.2003	19:00	24.03.2003	2:00	31	106	85	32	minor					Minor storm with the gradual beginning
28.03.2003	16:00	31.03.2001	3:00	59	98	124	81	moderate					Moderate storm with the gradual beginning
31.03.2003	6:00	01.04.2003	4:00	22	127	111	62	moderate					Moderate storm with the gradual beginning

Table 2
Amount of magnetic storms in the catalog

Storm class	1987	1988	1989	1990	1991	1992	1993	1994	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
minor	21	41	28	24	19	31	27	19	23	25	31	39	38	31	30	32	34	28	11
moderate	19	16	38	34	25	26	23	9	20	16	27	21	36	11	16	9	5	4	0
strong	0	7	8	7	9	7	8	7	1	5	4	4	1	4	5	1	0	0	0
extreme	0	1	4	1	9	1	0	1	0	3	6	2	2	2	4	0	0	0	0

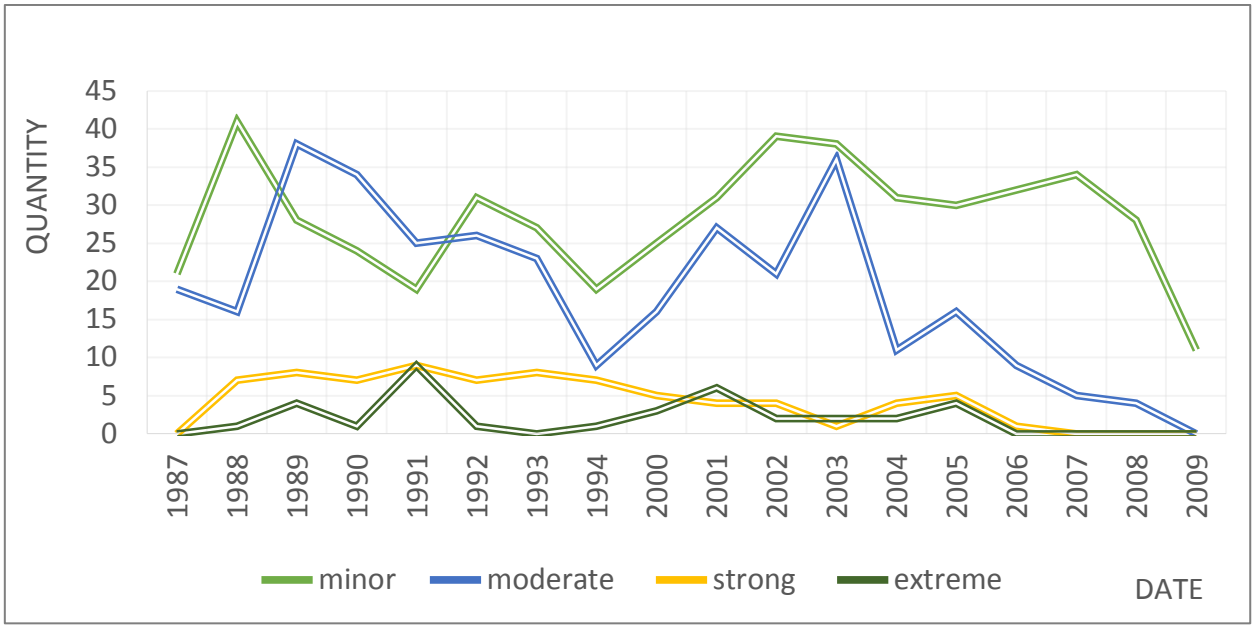

Figure 8. Graphical representation of the number of magnetic storms in the catalog

Magnetic anomaly zone

The magnetic observatory "Odessa" is situated near the intensive magnetic anomaly. Since the dome of the geomagnetic field extends to an altitude of about 90 km, into the ionosphere layer, where the variation (rapidly variable) component of the geomagnetic field is formed, regional magnetic anomalies can affect the manifestation of the variability of the geomagnetic field. When processing long-term, long-term observational data, the influence of the magnetic anomaly on the geomagnetic activity of the Earth was revealed [2,7,8, 9].

The map of the distribution of the anomalous geomagnetic field over the territory of Ukraine is shown in figure 9.

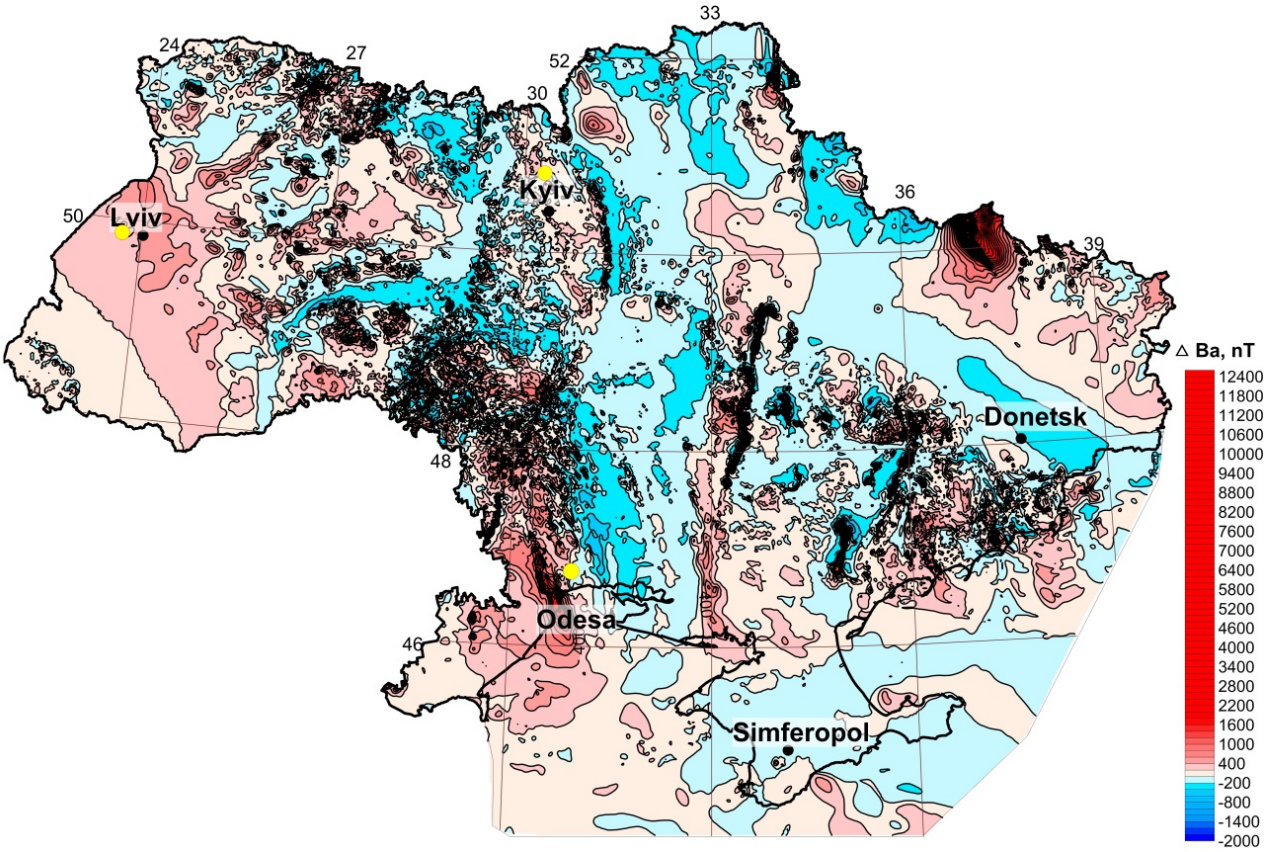

Figure 9. Magnetic Anomaly Map of Ukraine, obtained as a result of research carried out at the Institute of Geophysics of the National Academy of Sciences of Ukraine [3]. Yellow filled circles show the Kiev, Odessa and Lvov geomagnetic observatories

The identification of the magnetic anomaly influence on geomagnetic activity comparison of characteristics of magnetic storms at according to the magnetic observatories "Odessa" and “Moscow” was carried out [5]. The total duration of all magnetic storms throughout the year in Odessa is more than in Moscow (IZMIRAN) (fig. 10). Table 3 provides information on the duration of individual magnetic storms in the magnetic observatories "Odessa" and “Moscow” (IZMIRAN) for 1987-1995 and 2001-2003.

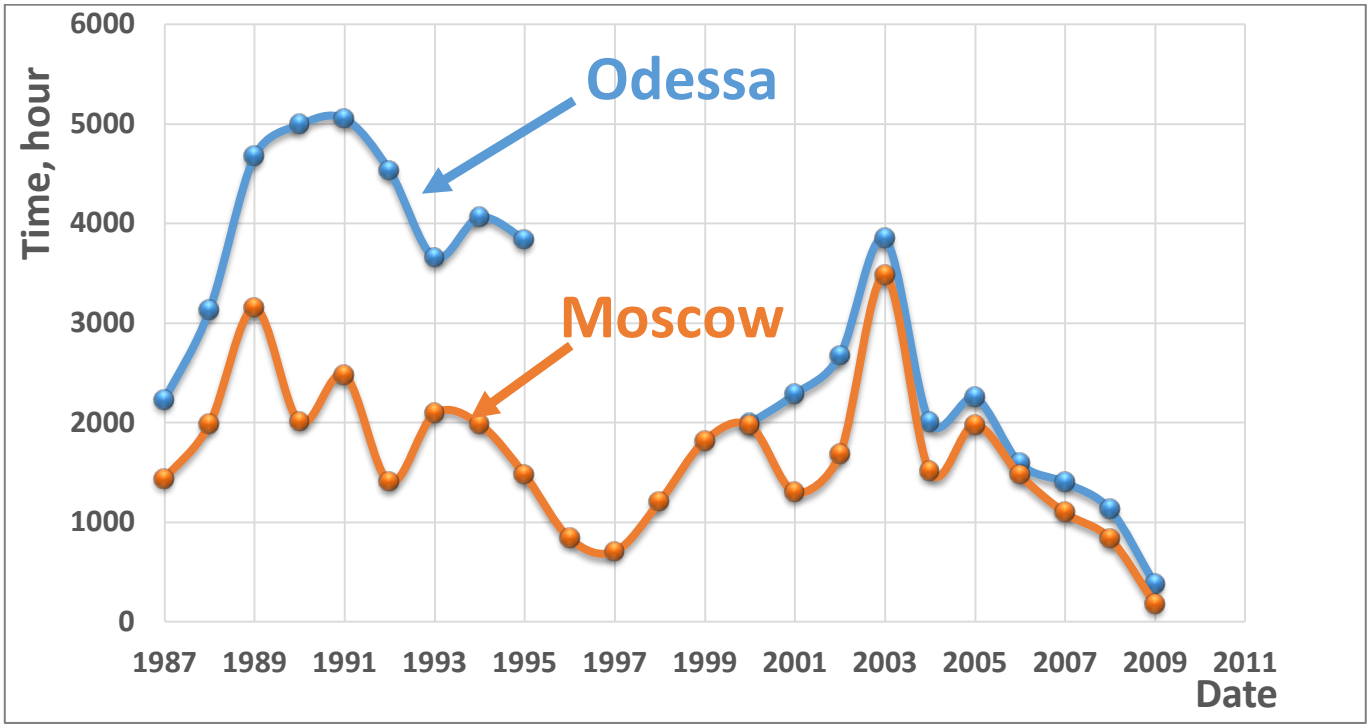

Figure 10. The total annual duration of magnetic storms according to the magnetic observatories "Odessa" and “Moscow”

Table 3

The duration of the most intense magnetic storms according to the data of the magnetic observatories "Odessa" and "Moscow" (IZMIRAN) for 2001-2003

2001			2002			2003		
Date	Odessa	Moscow	Date	Odessa	Moscow	Date	Odessa	Moscow
19.03.2001	38	40	10.01.2002	89	30	24.04.2003	108	41
28.03.2001	35	28	17.04.2002	43	21	26.06.2003	102	41
31.03.2001	70	9	19.04.2002	39	9	15.07.2003	52	2
08.04.2001	35	24	11.05.2002	30	22	28.07.2003	157	40
11.04.2001	29	18	23.05.2002	12	9	20.08.2003	116	56
18.04.2001	34	10	01.08.2002	88	26	15.09.2003	127	56
17.08.2001	36	8	01.10.2002	45	61	16.10.2003	91	40
21.10.2001	48	4	03.10.2002	65	50	15.11.2003	94	2
05.11.2001	62	40	02.11.2002	125	20	20.11.2003	43	9

Conclusions

1. On the base of data of magnetic observatory «Odessa» the catalog the magnetic storms is made. This issue of the catalog for 1987- 1995 and 2000-2009 years include: date and time of the beginning and end of a storm, the storm duration, amplitude on three elements of a magnetic field are specified: H, Z, D, the characteristic of magnetic storms.

2. The comparison duration of magnetic storms according to the magnetic observatory "Odessa" is longer than at “Moscow” (IZMIRAN).

3. It is planned to create a catalog of magnetic storms according to the Odessa station for the entire monitoring period of space radio sources at the RT URAN-4 in order to identify manifestations of geomagnetic disturbances during radio astronomical observations and their contribution to changes in radio source fluxes on decameter waves.

4. These studies will be supplemented by a comparative analysis of the characteristics of magnetic storms in the magnetic anomaly zone (Odessa) with data from other magnetic observatories.

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